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MANUFACTURE FOR SEPARATOR

Patent Number: JP2000106198
Publication date: 2000-04-11

Inventor(s): TOHARA KIYOSHI; SHIMIZU TERUO
Applicant(s):: MITSUBISHI MATERIALS CORP

Requested Patent: ☐ JP2000106198 (JP00106198)
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Priority Number(s):
IPC Classification: H01M8/02 ; H01M8/10
EC Classification:
Equivalents:

Abstract

PROBLEM TO BE SOLVED: To readily manufacture an inexpensive high-accuracy product, without the occurrence of chippings, etc., at production, by blasting the surfaces of a substrate after masking and forming fluid paths on the surfaces of the substrate.
SOLUTION: When fluid paths 2, 4 are machined on both sides of a carbon plate 1, the portions of the carbon plate 1 except for path forming parts are masked, thereafter beads are blasted over the entire carbon plate 1. End faces 14, 24 of projecting parts 10, 20 closely adhered with a masking material are protected by the masking material, to keep the initial flat surfaces of the carbon plate 1. Machine parts which are not adhered with the masking material are scraped by the beads, and deeper the fluid paths 2, 4 are formed, the less vertical the sides of them are, to form angles of inclination of 11, 21. Then, bases of the projecting parts 10, 20 are scraped by the beads flow more deeply than the bottoms 12, 22, thus small grooves 13, 23 are formed. Then, the remaining masking material is removed, thereafter the carbon plate 1 is impregnated with resin, furthermore the resin on the surfaces is removed. When it is used as a separator, gas permeating reaction is prevented between the fluid paths 2, 4.

スク部を損傷する等の不具合の発生を防止することができる。

【図面の簡単な説明】

【図１】　本発明の一実施形態を示すセパレータの断面図である。

【図２】　セパレータの酸素（空気）供給側を示す説明図である。

【図３】　セパレータの水素供給側を示す説明図である。

【図４】　突起部の配置の一例を示す説明図である。

【図５】　突起部の配置の他の一例を示す説明図である。

【図６】　突起部の配置の別の一例を示す説明図である。

【図７】　突起部の配置のさらに別の一例を示す説明図である。

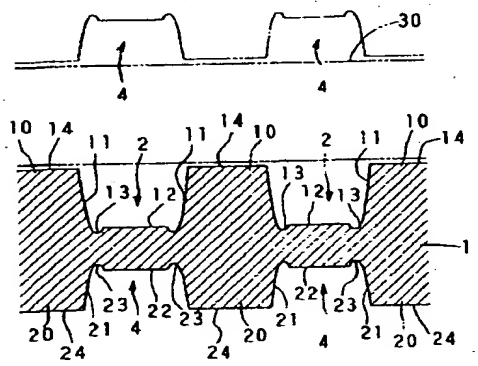
【符号の説明】

1　カーボン板（基板）

2、4　縦溝（流体通路）

3、5　横溝（流体通路）

【図１】



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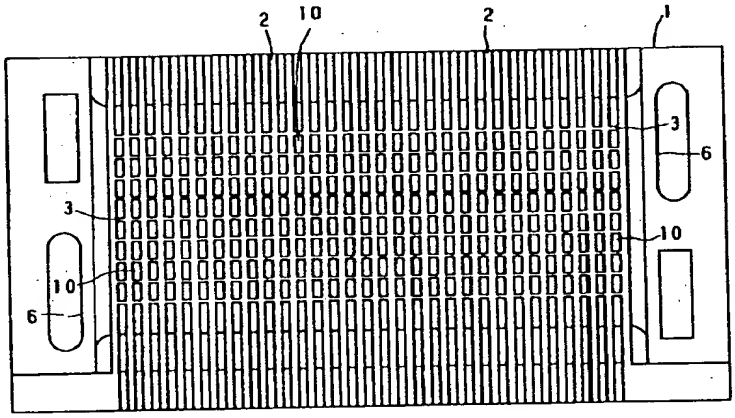

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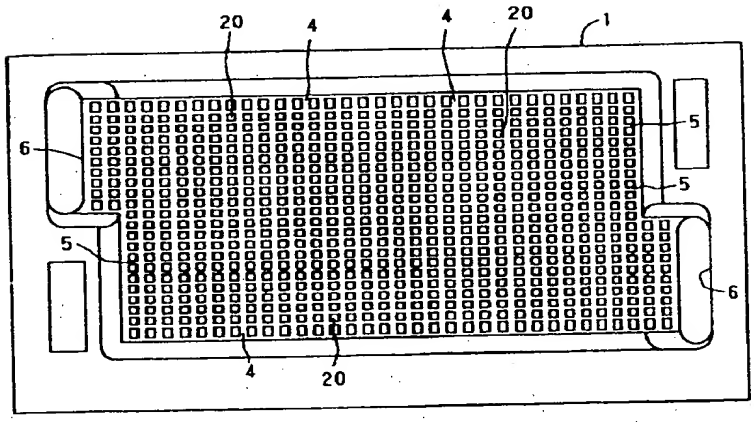

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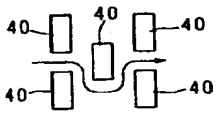

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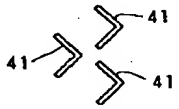

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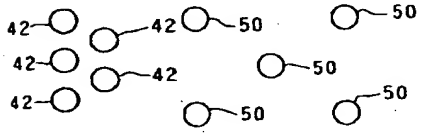

【図７】

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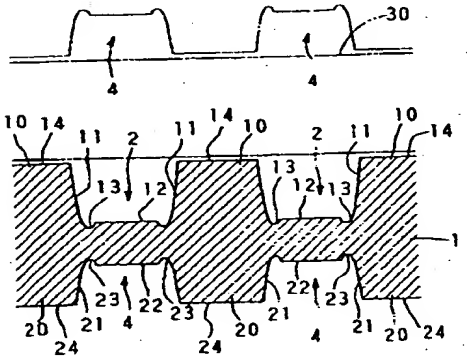

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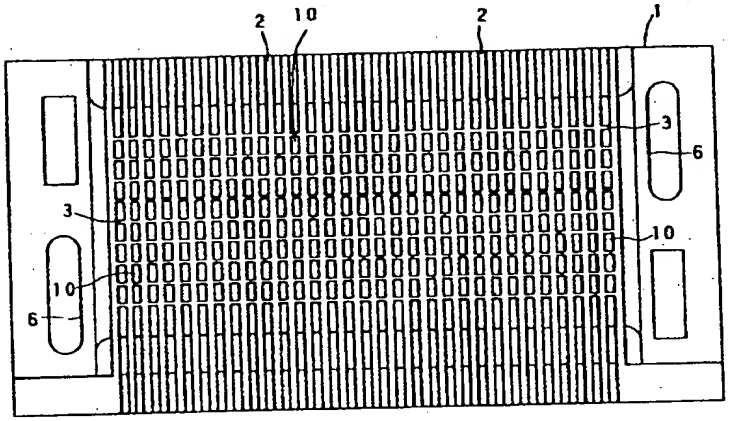

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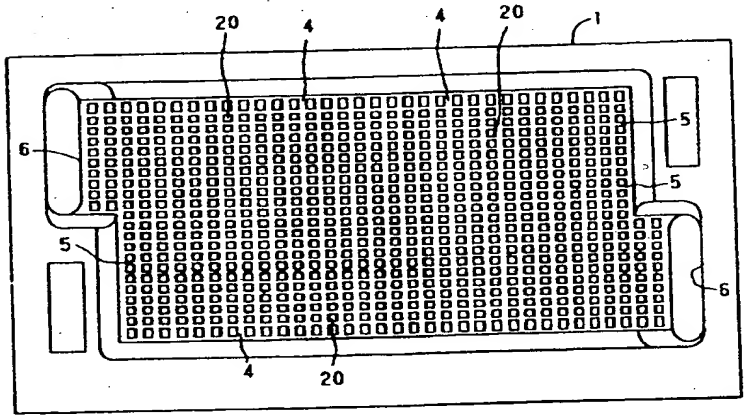

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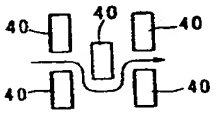

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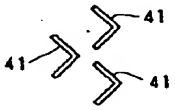

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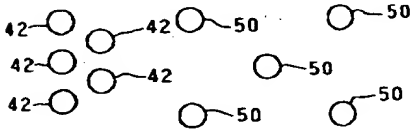

【図７】

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(33) **Priority Claim Country** Japan (JP)

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CC08 EE05 EE18 HH01 HH09

(54) **Title of Invention**

Production Method for Separators

(57) **Abstract**

Problem To offer a separator production method that can form fluid passages on a base-plate smoothly and reliably without mishaps such as breakages during production, and can produce highly accurate products readily and at low cost.

Means of Solution Locations on base-plate **1** to which a masking agent is bonded by a masking process are protected during a blasting process and remain unprocessed, while locations to which the masking agent is not bonded are processed by the blasting process to become fluid passages **2**, **3**, **4**, **5**.

Claims

Claim 1 A separator production method that is a production method for separators having fluid passages on the surface of a base-plate, and has the characteristic that, after performing a masking process on the surface of the said base-plate, fluid passages are formed on the surface of the said base-plate by carrying out a blasting process.

Claim 2 A separator production method, as stated in Claim 1, having the characteristic that the said base-plate is made of carbon plate.

Claim 3 A separator production method, as stated in Claim 2, having the characteristic that, before processing the fluid passages on the carbon plate, this carbon plate is impregnated with resin.

Claim 4 A separator production method, as stated in Claim 2, having the characteristic that, after processing the fluid passages on the carbon plate, this carbon plate is impregnated with resin.

Claim 5 A separator production method, as stated in any of Claims 1, 2, 3 or 4, having the characteristic that the masking agent used in the masking process is a resist film used for photo-processing.

Claim 6 A separator production method, as stated in any of Claims 1, 2, 3, 4 or 5, having the characteristics that the beads used in the blasting process have angular parts that scrape away the carbon plate, and that the diameters of the beads are 3 ~ 200μm.

Claim 7 A separator production method, as stated in any of Claims 1, 2, 3, 4, 5 or 6, having the characteristic that the beads used in the blasting process are silicon carbide or manganese oxide.

Claim 8 A separator production method, as stated in any of Claims 1, 2, 3, 4, 5, 6, or 7, having the characteristic that the shot pressure during the blasting process is 1kg/cm^2 ~ 5kg/cm^2.

Detailed Description of the Invention

[0001]

Technical Field of the Invention

The present invention concerns a production method for the separators used in solid high-molecular type fuel cells such as those mounted in electric cars.

[0002]

Prior Art

Hitherto, as this type of solid high-molecular type fuel cell, cells have been known in which two electrodes are provided one on each side of a solid high-molecular electrolytic film made of an ion-exchange membrane such as perfluorocarbon sulphonate; these electrodes being provided with separators having gas supply grooves that supply fuel gases such as hydrogen and oxidant gases such as oxygen. However, because these prior art separators are generally used for car engines there is a requirement for them to be light-weight, and carbon (graphite) has been used. Also, in prior art, separators are produced by forming gas supply grooves on each side of these carbon plates by mechanical processing.

[0003]

Problem to be Solved by the Invention

However, the carbon plate is easily damaged during the groove-forming process in the production method for the above prior art separators. In particular, there is the problem that, in the case of forming vertical grooves and horizontal grooves in a lattice formation, groove-processing is difficult and the product yield rate is poor.

[0004]

The present invention has been designed in the light of the above circumstances. Its objective is to offer a separator production method that can form fluid passages in a base-plate smoothly and reliably without mishaps such as breakages during production, and can produce highly accurate products readily and at low cost.

[0005]

Method of Solving the Problem

Claim 1 of the present invention is a separator production method that is a production method for separators having fluid passages on the surface of a base-plate in which, after performing a masking process on the surface of the base-plate, fluid passages are formed on the surface of the said base-plate by carrying out a blasting process. In Claim 2 of the present invention, the base-plate is made of carbon plate. In Claim 3 of the present invention, before processing the fluid passages on the carbon

plate, this carbon plate is impregnated with resin. In Claim 4 of the present invention, after processing the fluid passages on the carbon plate, this carbon plate is impregnated with resin. In Claim 5 of the present invention, the masking agent used in the masking process is a resist film used for photo-processing. In Claim 6 of the present invention the beads used in the blasting process have angular parts that scrape away the carbon plate, and the diameters of the beads are 3 ~ 200μm. In Claim 7 of the present invention, the beads used in the blasting process are silicon carbide or manganese dioxide. In Claim 8 of the present invention, the shot pressure during the blasting process is 1kg/cm^2 ~ 5kg/cm^2.

[0006]

Practical Configuration of the Invention

The following is a description, with reference to drawings, of a practical configuration of the present invention. Figure 1 is a cross-section of a separator showing a practical configuration of the present invention. Figure 2 is an illustration showing the oxygen (air) supply side of the separator. Figure 3 is an illustration showing the hydrogen supply side of the separator. Figure 4 is an illustration showing an example of the positioning of projections. Figure 5 is an illustration showing another example of the positioning of projections. Figure 6 is an illustration showing a further example of the positioning of projections. Figure 7 is an illustration showing a still further example of the positioning of projections.

[0007]

In Figures 1 ~ 3, reference numeral **1** is a carbon plate (base-plate) of almost rectangular shape. On one face of carbon plate **1**, as shown in Figure 2, broad vertical grooves (fluid passages) **2** and horizontal grooves (fluid passages) **3** that are narrower than vertical grooves **2** are respectively formed. In Figure 2, these vertical grooves **2** are set to a groove width of 2mm and a groove depth of 1.5mm. At the same time, the widths of these grooves and the walls between the grooves are set at approximately the same dimension. On the other hand, for each groove **3** in Figure 2, the width is set at 1mm and the depth at 1.5mm. At the same

time, the width of the walls between these grooves is set several times thicker than the groove width. These vertical grooves **2** and horizontal grooves **3** are designed as fluid passages for oxygen (air), and the oxygen (air) is designed to flow in the vertical direction in Figure 2.

[0008]

Also, on the other side of carbon plate **1**, as shown in Figure 3, broad vertical grooves (fluid passages) **4** and horizontal grooves (fluid passages) **5** of narrower width than vertical grooves **4** are respectively formed. In Figure 3, these vertical grooves **4** are set to a groove width of 2mm and a groove depth of 1mm. At the same time, the widths of these grooves and the walls between the grooves are set at approximately the same dimension. The positions of these vertical grooves **4** and of the above-mentioned vertical grooves **2**, as shown in Figure 1, are formed to agree in the same positioning on both faces of carbon plate **1**. On the other hand, for each groove **5** in Figure 3, the width is set at 1mm and the depth at 1mm. At the same time, the width of the walls between these grooves is set several times thicker than the groove width but also narrower than the walls between the above-mentioned grooves **3**. These vertical grooves **4** and horizontal grooves **5** are designed as fluid passages for hydrogen, and the hydrogen is designed to flow in the transverse direction in Figure 3, between passage holes **6** that are formed at both ends of carbon plate **1**.

[0009]

Moreover, projections **10** and **20**, which are bounded by vertical grooves **2**, **4** and horizontal grooves **3**, **5**, are respectively formed in tapered shapes with their tips being smaller than their bases, and are designed with inclined faces **11**, **21** from tip to base. Also, small grooves **13**, **23** are formed around the bases of projections **10**, **20** as boundaries between inclined faces **11**, **21** of projections **10**, **20** and bottom faces **12**, **22** of vertical grooves **2**, **4** and horizontal grooves **3**, **5**. The widths of these small grooves are set at 0.1 ~ 0.5mm (and preferably 0.3 ~ 0.4mm), while their depths are set at 0.1 ~ 0.9mm (and preferably 0.3 ~ 0.7mm).

[0010]

Furthermore, top faces **14**, **24** of projections **10**, **20** are made flat

faces, and these top faces **14**, **24** are opposite each other. The design is such that the two faces are sandwiched between ion-exchange membranes (solid high-molecular electrolytic films) **30** having platinum electrodes. Also, the surfaces of inclined faces **11**, **21** and bottom faces **12**, **22** that compose vertical grooves **2**, **4** and horizontal grooves **3**, **5**, and of small grooves **13**, **23** are rendered uneven, and their surface roughness is made 0.1 ~ 0.7mm Rz or Ra.

[0011]

In a separator composed in the above way, when processing vertical grooves **2**, **4** and horizontal grooves **3**, **5** in the two faces of carbon plate **1**, first, a process of covering the locations other than the groove-processing locations on carbon plate **1** with a masking material, in other words a masking process, is performed. The masking material used in this masking process may be anything as long as it has good adhesion to carbon plate **1**. Normally, a photo-resist film for photo-processing is used, and a pattern is printed and the masking material for the groove-processing parts is removed.

[0012]

In this state we shift to the blasting process. The blasting process is carried out using irregular beads of diameter 3 ~ 200μm with a nozzle shot pressure of 1kg/cm^2 ~ 5kg/cm^2 and blasting the beads evenly at carbon plate **1**. In this case, taking contamination of carbon plate **1** into consideration, silicon carbide (SiC) or manganese oxide (MnO) is used.

[0013]

By this means, vertical grooves **2**, **4** and horizontal grooves **3**, **5** are smoothly and reliably processed on the two faces of carbon plate **1**. That is to say, top faces **14**, **24** of the locations (projections **10**, **20**) to which the masking material adheres are protected by the masking material, and the original flat surfaces of carbon plate **1** are maintained. On the other hand, the groove-processing parts to which the masking material does not adhere are smoothly cut away by the angular parts formed in the irregular beads. At this time, as the grooves become deeper and deeper, the groove side faces are not cut perpendicularly but become inclined faces **11**, **21**. At the same time, by the bead flow being guided along those inclined faces

11, 21, small grooves 13, 23 are formed by the bases of projections 10, 20 being cut away deeper than bottom faces 12, 22.

[0014]

Next, after removing any masking material remaining on carbon plate 1, resin is impregnated into carbon plate 1, and then any resin on the surfaces is removed by washing. A thermo-setting resin such as, for example, phenol resin or epoxy resin is used as this resin. Also, as the resin impregnation method, a method is used in which, for example, after de-aerating carbon plate 1 under reduced pressure, the resin is impregnated into carbon plate 1 by immersion in a thermo-setting resin, and then a hardening process of pressurising at a specified pressure and heating at a specified temperature is carried out.

[0015]

As a result, when used as a fuel-cell separator, reaction of the gases through permeation between the various grooves 2 and 4 is prevented before it can happen, while carbon plate 1 is strengthened to a uniformly strong surface that is difficult to break. Incidentally, as far as the resin impregnation process is concerned, this has been described as being performed after the groove processing on carbon plate 1. However, the invention is not limited to this, and it may also be performed before groove processing on carbon plate 1. In this case, to offset the fact that randomness of hardness readily occurs and there may well be randomness of groove depths and the like, from the point of constructing grooves 2, 3, 4, 5, the uneven configuration left by blasting is distinctly formed.

[0016]

Separators produced in the above way are used, in the same way as in prior art, to sandwich ion-exchange membranes 30. In this case, flat surfaces are respectively maintained on top faces 14, 24 of projections 10, 20 that sandwich ion-exchange membrane 30. Therefore a squeezing pressure can be reliably applied, and ion-exchange membrane 30 is securely held. Also, the bases of projections 10, 20 are formed broader than their tips, while the angles formed by top faces 14, 24 and inclined faces 11, 21 are formed as obtuse angles. Therefore it is difficult for the tips to

be damaged and the strength of projections **10**, **20** is satisfactorily ensured. From this point also, retention of ion-exchange membrane **30** is reliably performed.

[0017]

Air (oxygen) is caused to flow in the vertical direction in Figures 2 and 3 using vertical grooves **2** and horizontal grooves **3**, while hydrogen is caused to circulate in the transverse direction using horizontal grooves **5** and vertical grooves **4**. By this means, electricity is generated in ion-exchange membrane **30** between vertical grooves **2** and **4**, which face each other, by the reaction of hydrogen and oxygen. In this case, the flows of oxygen and hydrogen are disturbed and become turbulent due to small grooves **13**, **14** of vertical grooves **2**, **4** and horizontal grooves **3**, **5**. Therefore the flows of the oxygen and hydrogen in contact with the sides of ion-exchange membrane **30** are rendered turbulent. Thus, effective power generation is performed by a guaranteed reaction because the input of fresh oxygen and hydrogen is constantly changing.

[0018]

Also, together with the above reaction, ion-exchange membrane **30** generates heat. However, as stated above, top faces **14**, **24** of projections **10**, **20** are made level surfaces. Therefore the heat from ion-exchange membrane **30** is smoothly conducted from these top faces **14**, **24** to the carbon plate **1** side. At the same time, due to inclined faces **11** of projections **10**, the contact area with the air (oxygen) that contributes mainly to cooling is greater than in the case of the perpendicular faces obtained by prior art mechanical groove-processing. Therefore the reaction heat is reliably transferred from inclined faces **11** to the air. At the same time, the flow of air is disturbed and rendered turbulent by small grooves **13**, and thus the separator is effectively cooled because the air in contact with inclined faces **11** is constantly changing. In addition, by making the surfaces of inclined faces **11**, bottom faces **12** and small grooves **13** that compose vertical grooves **2** and horizontal grooves **3** in a roughened form, the contact surface with the air becomes greater, and therefore, to that extent, the quantity of heat transferred from carbon plate **1** to the air becomes greater, and cooling is performed even more

smoothly. By this means the temperature of ion-exchange membrane **30** can be kept at the specified temperature (approximately 130°C).

[0019]

Incidentally, the present practical configuration has been described using vertical grooves **2**, **4** and horizontal grooves **3**, **5** that are orthogonal to each other, and using rectangular truncated pyramidal projections **10**, **20** that are surrounded by these vertical grooves **2**, **4** and horizontal grooves **3**, **5**. However, the present invention is not limited to this. Needless to say, circular truncated conic or elliptical truncated conic projections and triangular truncated pyramidal or polygonal truncated pyramidal projections may also be used. Moreover, for the positioning of the projections also, as shown in Figure 4, Figure 5 or Figure 6, rectangular truncated pyramidal projections **40**, <-shaped (or C-shaped) projections **41** or circular truncated conic projections **42**, may respectively be positioned so that the flow of gas (air, oxygen or hydrogen) bends or curves. Nor is this invention limited to this, and there may also be ㄱ-shapes (or reversed S-shapes or "good luck" swastikas), or C-shapes (or S-shapes). In this case, the effect is exhibited of the gas residence time becoming longer and thus the contact time with ion-exchange membrane **30** becoming longer. On the other hand, if, as shown in Figure 7, circular truncated conic projections **50** are randomly positioned using no more than those required to hold ion-exchange membrane **30**, gas can be made to flow through at low pressure. This will exhibit the effects of the providing a larger reaction area, while resin-impregnation is easier to perform.

[0020]

Moreover, the beads used in the above-mentioned blasting process in the present practical configuration were described as being of irregular shape. However, the invention is not limited to this, and they may also be of such shapes as cubes, rectangular parallelopipeds or polyhedrons. In other words, needless to say, any shape may be used provided it has angular parts that will scrape away carbon plate **1**. Incidentally, the present practical configuration has been described as using carbon plate as the separator. However, this invention is not limited to this, and

fluid passages may be formed by a blasting process using beads such as siliconia on the surfaces of metallic plates such as titanium. In this case, separators can be obtained that are superior from such aspects as mechanical strength, corrosion resistance and thermal conduction.

[0021]

Effects of the Invention

Claim 1 of the present invention forms fluid passages on the surfaces of a base-plate by performing a blasting process after carrying out a masking process on the surfaces of that base-plate. Therefore, due to this masking process, the locations to which the masking material adheres are preserved during the blasting process and remain in an unprocessed state while, due to the blasting process, locations to which the masking material does not adhere are processed to become fluid passages. By this means, there is no occurrence of mishaps such as breakages during production, and fluid passages can be formed on the base-plate smoothly and reliably. Thus a highly accurate product can be manufactured easily and at low cost. In Claim 2 of the present invention the base-plate is made of carbon plate. Therefore, a light-weight product can be manufactured, and is suitable for mounting in vehicles. In Claim 3 of the present invention, resin is impregnated into a carbon plate before processing fluid passages in that carbon plate. Therefore, impermeability to gas can satisfactorily be given to the carbon plate by this resin-impregnation process, while, in addition to being able to strengthen the surface to a uniform degree of strength that makes the carbon plate difficult to break, it is possible to form the surfaces that compose the fluid passages in a distinctly uneven shape by the blasting process. In Claim 4 of the present invention, resin is impregnated into a carbon plate after processing fluid passages in that carbon plate. Therefore, impermeability to gas can satisfactorily be given to the carbon plate by this resin-impregnation process, while, in addition to being able to strengthen the surface to a uniform degree of strength that makes the carbon plate difficult to break, the resin-impregnation process has no effect on the blasting process, and formation of the fluid passages can be accurately performed by the blasting process. In Claim 5 of the present

invention, the masking material used in the masking process is resist-film used in photo-processing. Therefore, the normally-used photo-resist process can be utilised and it can be processed easily and stably, while the masked parts can be reliably protected during the blasting process through the masking material adhering firmly to the base-plate. In Claim 6 of the present invention, the beads used in the blasting process have angular parts that scrape away the carbon plate, and the bead diameters are 3 ~ 200μm. Therefore, fluid passages can be simply processed in the carbon plate by the angular parts of beads having specified diameters. In Claim 7 of the present invention, the beads used in the blasting process are silicon carbide or manganese oxide. Therefore, even if these beads remain on the carbon plate during fluid passage processing, the problem of contamination of the carbon plate will not arise, and it is possible to manufacture a sound product. In Claim 8 of the present invention, the shot pressure during the blasting process is 1kg/cm^2 ~ 5kg/cm^2. Therefore, the carbon plate can be smoothly and rapidly processed using the specified shot pressure, and the occurrence of mishaps such as damage to the masked parts can be prevented.

Brief Descriptions of the Drawings

Figure 1 is a cross-section of a separator showing a practical configuration of the present invention.

Figure 2 is an illustration showing the oxygen (air) supply side of a separator.

Figure 3 is an illustration showing the hydrogen supply side of a separator.

Figure 4 is an illustration showing an example of the positioning of projections.

Figure 5 is an illustration showing another example of the positioning of projections.

Figure 6 is an illustration showing a further example of the positioning of projections.

Figure 7 is an illustration showing a still further example of the positioning of projections.

Key to Reference Numbers

1 Carbon plate (Base-plate)

2, 4 Vertical grooves (Fluid passages)

3, 5 Horizontal grooves (Fluid passages)

TRANSLATOR'S NOTES

1. **Original, Page (1), Names of Inventors and Agent.** - Japanese names, and particularly given names, frequently use unusual character readings. This is one of the reasons for the very wide use of name/visiting cards in Japan. In this case, the problem is made more difficult by blurring caused by photocopying. Cases in which the reading is unknown or the characters are illegible have been indicated by "[????]". (When translating I always give the surname in upper case and place it after the given name).

2. **Original, Page (4), Left-hand Column, Lines 32 to 37.** - Several Japanese characters (plus C and S) are given in these lines to denote various configurations (both versions of the swastika are listed in Japanese character dictionaries). Where possible I have used similar signs (the mathematical "<" and the Hebrew "ב" in the translation, but in other instances I have had to resort to descriptions.

   It is also noted that "C-shape" occurs twice in these lines, once in line 33 and again in line 36.

3. **Original, Page (4), Left-hand Column, Line 32.** - Although the "<" sign is given in the text here, the ">" sign is shown in Figure 5.